Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CH367

Course Name: NUMERICAL METHODS FOR PROCESS ENGINEERS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks Marks

1 a) Perform five iterations of the bisection method to obtain the smallest positive root of the equation $f(x) = x^3 - 5x + 1 = 0$. (7)

b) Extract a quadratic factor $x^2 + px + q$from the polynomial$x^4 + x^3 + 2x^2 + x + 1 = 0$ by a single iteration of the Bairstow method. Use the initial approximation $p_0 = 0.5\ and\ q_0 = 0.5$ (8)

2 a) Solid particles having a diameter (d_p) of 0.12 mm, shape factor $\emptyset_s = 0.88$, and a density (ρ_p) of 1000 kg/m^3 are to be fluidized using air at 2.0 atm and 25^{0}C. The voidageat minimum fluidization(ε_{mf}) is 0.42 and the viscosity of air under these conditions(μ) is 1.845 x 10^{-5} kg/(m-s).The density of air(ρ) is 2.374 kg/m^3. Obtain the minimum fluidization velocity (v_{mf}) by Newton-Raphson method using the Ergun equation given below: (8)

$$\left[\frac{1.75\rho}{\emptyset_s d_p}\frac{(1-\varepsilon_{mf})}{{\varepsilon_{mf}}^3}\right]{v_{mf}}^2 + \left[\frac{150\mu}{{\emptyset_s}^2}\frac{(1-\varepsilon_{mf})^2}{{d_p}^2{\varepsilon_{mf}}^3}\right]v_{mf} - (1-\varepsilon_{mf})(\rho_p - \rho)g = 0$$

b) Explain the method of relaxation for solving simultaneous linear equations, stating its conditions for convergence. (7)

3 a) Explain the method of determining the minimum eigen value of a matrix using the power method. Also state the major drawback of using the power method for finding all eigen pairs of a matrix. (7)

b) Apply Gauss-Jordan method to solve the equations: (8)

$$x + y + z = 9$$
$$2x - 3y + 4z = 13$$
$$3x + 4y + 5z = 40$$

PART B

Answer any two full questions, each carries 15 marks

4 a) Surface tension of water is measured at various temperatures. It decreases with temperature as follows: (8)

T(^{0}C)	20	30	40	50	60
γ(mN m^{-1})	72.8	71.2	69.6	67.9	66.2

Fit a Lagrangian polynomial and determine the surface tension at 37^{0}C.

b) Construct the divided difference table for the data: (7)

x	0.5	1.5	3.0	5.0	6.5	8.0
f(x)	1.625	5.875	31.0	131.0	282.125	521.0

Hence find an approximation to the value of f(7).

5 a) Derive Stirling's formula from Newton's interpolation formula. (7)

b) Given that: (8)

x =	1	1.1	1.2	1.3	1.4	1.5	1.6
y =	7.989	8.403	8.781	9.129	9.451	9.750	10.031

find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at x = 1.1

6 a) The velocity of a rocket can be computed from the following formula: (7)

$$v = 2 \times 10^3 ln\left[\frac{10^5}{10^5 - 2 \times 10^3 t}\right] - 10t$$

where v is in $\frac{m}{s}$ and t is in $seconds$. Find an estimate of the distance the rocket will travel in 30 seconds using Simpson's 1/3rd rule.

b) (8)

$$I = \int_0^2 \frac{dx}{x^2 + 2x + 10}$$

Write I as $I_1 + I_2$ $where$ $I_1 = \int_0^1 f(x)dx$ and $I_2 = \int_1^2 f(x)dx$ and evaluate each of the integrals by Gauss-Legendre three-point formula.

PART C

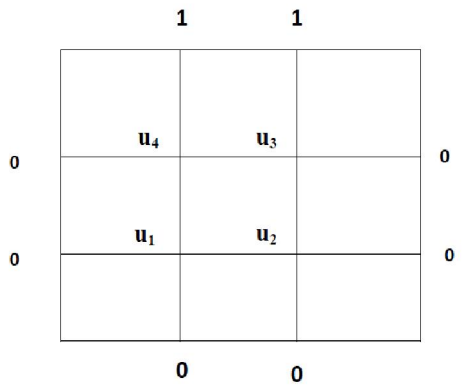
Answer any two full questions, each carries 20 marks

7 a) Use the Taylor series method of order four to solve the initial value problem $u' = t^2 + u^2,\ u(0) = 1$ for the interval (0, 0.4) using two subintervals of length 0.2 (10)

b) Solve the initial value problem using fourth order Runge-Kutta method $\frac{dy}{dx} = y - x, 0 \le x \le 0.2$ given $y(0) = 0$, using step size h = 0.1 (10)

8 a) Given $\frac{dy}{dx} = x^2(1 + y)$ and $y(1) = 1,\ y(1.1) = 1.233,\ y(1.2) = .548,$ $y(1.3) = 1.979,$ $evaluate$ $y(1.4)$by Adams method. (10)

b) Solve $u_{xx} + u_{yy} = 0$ for the square mesh with boundary values as shown in the figure below. Iterate till the mesh values are correct to two decimal places. (10)



9 a) The temperature distribution in a cylindrical rod with internal heat source is given by the differential equation: (10)

$$\frac{d^2\theta}{dr^2} + \frac{1}{r}\frac{d\theta}{dr} + \dot{Q} = 0$$

The boundary conditions are $\frac{d\theta}{dr} = 0, at\ r = 0\ and\ \theta = 1, at\ r = 1.$

Solve the problem by finite difference method.

b) Evaluate the pivotal values of the equation $u_{tt} = 16u_{xx}$, taking $\Delta x \equiv 1\ upto\ t = 1.25$. The boundary conditions are $u(0,t) = u(5,t) = 0$, $u\ (x,0) = 0\ and\ u(x,0) = x^2(5-x)$. (10)

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